



# RCA INSTITUTES

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## Technical Lesson 35

### COMMON FAULTS AND TROUBLES

Much has been said and much has been written on the many troubles that arise in Radio receivers as to what causes their failure and how to correct troubles when they occur. Radio publications have devoted columns and pages in answering individual problems. These have been of invaluable assistance to the individual, but in nearly all cases have referred to specific conditions.

Here we will endeavor to group service problems under general classifications and prescribe methods of diagnosing them followed by a prescription for correcting them.

Failure of receiving sets to operate may be grouped under certain general classes, namely:

- Lack of operating experience on the part of the user.
- Location.
- Defective accessories.
- Open circuit.
- Short circuit.
- High resistance connection.

Lack of operating experience may be the result of not following out instructions carefully enough, or as is sometimes the case the instructions are not complete enough, and are not entirely clear to the novice. It may be the result of insufficient instruction on the part of the service man who made the installation. Then too, it may be the results of impatience on the part of the customer. It is a peculiar condition, but a fact nevertheless, that the first night a customer has a set, he feels that he should be able to get great distances. The responsibility for this condition rests with either the salesman who sold the set or the service man who failed to correct this fallacy in the customer's mind, or with the manufacturer of the set for over advertising his product, and being a little too optimistic as to the possibilities of reception. A manufacturer who in New York City receives the Pacific Coast stations on his product is not justified in making a general statement that this is so and give the impression to the reader of the advertisement that that particular receiver will perform likewise in every other locality. That is incomplete advertising and should be discouraged as it has a detrimental effect on the industry as a whole.

Under the caption of location many factors must be considered. The type of building in which the installation is made, the proximity to steel buildings, power lines, trolley and railway lines, and the geological and

logical and topographical conditions surrounding the installation are all important factors. Certain areas appear to be dead to certain stations, while at the same time particularly good for others. We do not believe that this is due to the area being so called "dead" but due to the distortion of the wave front from the transmitting station causing it to be deflected in such a manner to render reception of signals from that station very difficult or impossible in that particular location.

Under defective accessories we may include defective tubes, batteries, loud speakers, antenna and ground installations, also improper battery or power connections. Many sets fail or are returned to the dealer as unsatisfactory because of poor antenna and ground installations. Many sets of good quality and capable of delivering satisfactory results fail because the loud speaker that is used with it does not have the proper electrical characteristics to operate satisfactorily in conjunction with the receiver. Tubes will also cause trouble as they are subject to certain defects because of their delicate construction.

Open circuits are generally found in the movable connections of the set such as condenser pig tails, loop leads, loud speaker leads, and any other connection that is subject to movement or vibration in the normal operation of the set. Open circuits may also result from burned out transformers or from mechanical failures in telephone jacks, rheostats, and switches.

If a set has been once tested and found to be O.K., short circuits rarely occur. When they do it is the result of a mechanical failure of the moving parts or of tinkering with the mechanism of the set. It will sometimes happen that the pig-tail of a moving element of the receiver will break and fall in such a way as to cause a short circuit of that element. This is particularly true of the pig-tails of variable condensers. If the filament of the tube should break there is a possibility of the filament falling in such a way as to cause a short circuit between itself and the plate and grid elements of the tube. When such a fracture of the filament occurs the voltage of the B or C battery as the case may be, is short circuited through the conductors involved. This type of short circuit is generally of very brief duration as the filament will generally burn out as soon as the short occurs. A contact between the grid and plate element of a tube is a more serious type of short circuit, resulting in the rapid deterioration of the B and C batteries, and may possibly cause a burn out of the transformer windings in the circuits involved.

The foregoing troubles are relatively easy to check up as they are immediately apparent or can easily be located by a continuity of circuit test.

The most difficult type of failure to locate is that caused by a high resistance connection. It is not only difficult to locate, but it is difficult to determine. This condition will cause the set to operate indifferently with rather unsatisfactory results. This condition is

sometimes mistaken as location trouble. A high resistance is possible at any connection in the receiver. Soldered connections that are soldered with a corrosive flux that has not been properly treated after the soldering operation are probably the worst offenders. Weak mechanical springs in telephone jacks and switches may also introduce high resistance connections.

Radio sets, like human individuals, are very much the same the world over. They fail or succeed according to a few fundamental laws. They are subject as it were to the same ills. The doctor can diagnose the trouble in a man's system whether he be well dressed or poorly dressed, whether his name be Smith or Jones, because he knows the fundamental laws governing the human system and is not confused by size or shape or a difference in physical dimensions or shape.

One doesn't have to be a Radio engineer to be able to service a radio set. He does need experience to become adept, and a good knowledge of the fundamentals is valuable. One must be of course familiar with the various parts that are commonly used in radio receivers such as rheostat, jacks, and so on, and must know in a general way, the function of each.

Given a first-aid manual, the average individual with an ordinary amount of common sense and an ability to follow directions might go out and administer first-aid treatment to a drowning man, and if he followed the directions properly might effect a recovery. A doctor could do no differently. His experience would permit him to handle the case more skillfully and his intimate knowledge of the workings of the human systems would permit him to diagnose the case more quickly from the apparent symptoms, but the man with the first-aid manual would produce the same results in a little longer time and yet he knows nothing of the medical science.

For instance, what does a doctor do when he is called in to treat a sick person? The first thing he generally does is to feel the pulse and while doing that, starts a series of questions as to the length of time the person has been ill, where the pains are, and he may even go as far as to inquire into the family history. Let that be the practice of the radio service man. Do not immediately get out the tool bag and start pulling the set apart, but try and find out what the difficulty is by questioning the customer. What would you think of a doctor if at first sight of every patient, he started to operate, and yet you will see a service man start immediately to pull the set out of the cabinet and look for trouble, and the trouble may be in a battery connection.

What we will attempt in this instruction is to outline a first-aid manual for the treatment of sick radio sets, that will enable you to recognize trouble and make the necessary repairs. We will treat the subject from a practical viewpoint and refer only to theoretical discussions when absolutely necessary to express our point. We have prepared a list of complaints that are most frequently heard, and we

will analyze each complaint as to the possible reason for it.

Let us start with a suggestion to the dealer, or for that matter, to any one who sells a radio receiver. Test all sets before sale. This takes but a very few minutes and will surely pay well in avoiding dissatisfaction as well as time that is sometimes necessary to service a defective set that has been shipped to a customer. A radio receiver that is working properly today does not as a rule go bad tomorrow, and if such an installation does fail, the dealer may feel that the trouble is due to a defective accessory rather than the set itself. When the service man is called on to service such a set he has the confidence that the set is O.K. and he will immediately be able to concentrate on the real probability of failure rather than imaginary ones.

Then too, if the dealers would acquaint the customer with the limitations of radio reception, what to expect and what not to expect, service problems would be minimized. Acquaint the customer as to the probable length of time his batteries will last. This is quite important, and if followed out, will avoid some very disagreeable service jobs. For example, when a man purchases a radio set he becomes quite enthusiastic and will read all available literature on the subject, and at the end of the month he has absorbed just enough information to be dangerous. Just about this time the signals on his set will start to decrease and he will remember having read somewhere that this might be caused by a defective transformer, and he immediately gets out the tools to make the repair, and then the dealer has a regular service job on his hands. Had the dealer in the first place acquainted the customer with the facts concerning the life of the batteries, the customer would be more than likely to recall such information and take the proper steps.

The question has been asked at times, "What should the service man's equipment consist of?"

He should carry the necessary tools and apparatus to be able to run a complete test on the set to be serviced and be able to make any minor repair necessary. We suggest the following items:

Set of tested tubes, multi-scale voltmeter of good quality, pair of head phones, large and small screw drivers, small soldering iron, solder and non-corrosive flux, spare wire and tape, pliers, test leads with clips, pipe cleaners, large piece of cloth, set of B and C batteries (small).

When a service man goes into a customer's home he is usually going there as a representative of a commercial establishment. He should be instructed to be courteous and considerate. If he must take a set out of the cabinet for adjustment he should use the piece of cloth provided in his kit to protect the surface of the table he works on. He should answer all questions asked him no matter how absurd they may appear to him. The customer does not hold that point of view or he would not

ask them. The customer generally has one question that he would like to have answered, and in his mind the service man must be an expert, in order to be able to do such work, and so he unburdens his mind. The service man should respect this attitude on the part of the customer and should do his best to point out fallacies tactfully and set the customer right in his ideas about radio. The service man should make the customer enjoy his visit; if this is done the service man becomes a valuable asset to a business and is a potential salesman.

The service man, before he starts to make any adjustments other than turning on the set and trying the various controls, should question the customer as to how it happened, the time, place and conditions surrounding the failure. Such questions as the following:

- How long has the set been in operation?
- Was the set operating satisfactorily up to the time of failure?
- Were you tuning the set when the failure occurred?
- If so what control were you moving?
- Did you make any change in the connection of the batteries, if so what were they?
- Did it suddenly stop operating?
- Was there any squeal or howling sound in it just prior to its failure?
- Were you moving the loop?
- Did the loud speaker fall?
- Is the antenna O.K?

In short, have the customer re-enact the conditions at the time of failure. Get all the symptoms and a surprising amount of time may be saved in running down the difficulty. If sufficient questions are asked, the customer will generally give you the real cause of trouble or he will suggest something to you in the course of inquiry that will point out just what the cause of failure was. Sets as a rule do not go bad of themselves but the failure usually occurs while some operation is taking place, such as plugging in the loud speaker, turning the condensers or making a change in the battery connections.

The length of time that a set has been in operation will be an indication of various types of troubles. A set that has recently been installed is subject to a certain type of failure while a set that has been in operation for a year or more is subject to other types of failure.

If a set has been installed for a period of two weeks or less, outside of the inability of the customer to produce the desired results there are only a few reasons why the set will fail, and they are:

- A defective tube.
- Defective battery or battery connection.
- Loud Speaker connection loose in telephone plug.
- Burnout of transformer.

Of course there may be other reasons but these are the most common and are given in the order of their possibility of occurrence.

If the set has been in operation for a month or six weeks and has been giving satisfactory service for that period the cause of failure is generally due to the weakening of the batteries.

If the set has been in operation for a period of six months or a year, the possibilities of trouble will increase. If the failure in this type of installation has been gradual, the first thought would be that the tubes were becoming deactivated through continual use. If the breakdown was sudden, a mechanical failure might be expected in one of the movable connections or pig tails. A burned out transformer could be expected in sets of this class. If the trouble is due to a noise condition, the failure might be ascribed to dust and dirt accumulations on the condenser plates or other important parts of the receiver. The defect might also be due to a soldered connection. It will require as a rule a rather long period of time for a soldered connection to corrode to such a degree as to cause this condition. The local atmospheric conditions under which the set has been operating may have some bearing on the cause of failure. If the set has been operating near the seashore and has been subjected to the action of salt atmosphere it may have caused sufficient corrosion of the connections or other metallic parts so as to introduce high resistance or leakage paths. Moisture may saturate the cheaper grades of dielectrics to such an extent as to cause high frequency short circuits.

If a set has been operating for a long period of time and has given satisfactory results and it develops noises and scratching sounds, do not look for a loose connection in the wiring of the set, but rather look for an open circuit in some of the moving parts. Worn mechanical parts are often mistaken for loose connections in the wiring. The wiring is absolutely stationary and it is not at all likely that it will be disturbed in the ordinary use of the set so as to cause a failure due to a loose connection. Vernier drive shafts and vernier plates will wear loose and while apparently are making a perfect contact to the metal surfaces of the condenser when the set is brought into a critical condition as is the case when receiving distant stations, will cause all kinds of noises that might be thought due to a loose connection in the wiring.

Another item to be considered in the servicing of radio sets is the cost of the original apparatus. Radio like any other merchandise, is a matter of price. As a rule, the more you pay for a set, the better will be the quality of the equipment you get and you may reasonably expect longer and more satisfactory service from it. In a high grade receiver, the mechanical failures are less frequent than in the cheaper grades of sets. The same is true of electrical failures. The cheaper grades of sets are much more subject to climatic conditions than are the better grades. We have compiled a series of complaints and we will take each one up in turn as to what it suggests as the possible cause of failure.

1. The set just stopped operating. It was giving excellent results but it suddenly stopped.

This complaint is quite unsatisfactory from a service man's point of

view. It does not suggest anything definite and it may be the result of many things. Sets do not generally go bad in this manner. It generally occurs when some operation is taking place, whether it be tuning or making adjustments or plugging in the loud speaker or revolving the loop. The service man should inquire just how the failure took place, just what the customer was doing when the set failed. If the failure occurred when some adjustment was being made, he should look for a broken connection or a mechanical breakdown in the control being used at the time. There are several causes for a set failing completely and suddenly, and they are principally, a burned out tube, a burned out transformer, a broken connection or a short circuit. A broken loop connection will also cause complete failure as well as a burned out loud speaker, but the list just given represents the principle causes for a complete and sudden failure.

A burned out tube will be immediately obvious and should be replaced. A broken battery connection or pig tail may be located by inspection and necessary repairs made. A defective loud speaker may be determined by replacing the loud speaker with a pair of head phones and noting whether the head phones operate satisfactorily. There is a possibility of failure in sets that employ a large bi-pass condenser which is connected across the plate supply. In event of this condenser becoming short circuited it will cause the B batteries to drop in voltage very rapidly and if the short is complete enough, the batteries will heat up. This can be very quickly determined by breaking the connection through the negative B battery. If a heavy spark occurs, it is an indication that there is a short circuit in the B battery supply which may be due to this condenser. In testing this condenser should by chance the tubes be lit when the B battery connection is broken, a small spark will be present. The small spark is due to the normal drain on the B batteries and represents the total plate current of the tubes in the set. If the tubes are not lit, no sparking should occur when the battery connection is broken, and if there should be, there is an indication of a short circuit within the set. Of course, there is a possibility of a wire breaking free in the set itself and falling in such a way as to cause a short circuit, but this is immediately apparent on inspection. There is also a possibility of a short circuit of the elements in the tubes.

"I cannot get distance" is a general criticism that is met with radio receivers of all types. In some cases it is the result of over advertising on the part of the manufacturer which leads the customer to believe that he will get distant stations under any and all conditions just by turning the dials. The manufacturer or dealer who employs this type of advertising sooner or later digs his own grave as you cannot fool the public all of the time.

The most general cause for this complaint is due to the inability of the customer to tune the set properly so as to get the most out of it. The obvious remedy for this is to instruct him further in the operation of the set. The service man should spend an evening with him and show him just how to do it, and once the customer knows that the set is capable of receiving distance, he will never admit that he cannot get it.

A defective tube will sometimes prevent distance receptions. Perhaps one of the tubes used in the radio frequency circuit is not particularly adapted for that purpose, but will make an ideal detector or audio frequency amplifier. Try interchanging tubes so as to get the best possible combination. Do not make a practice of interchanging tubes, after the most satisfactory combination has once been determined. This is particularly applicable to dry cell tubes. Because of the extremely delicate structure, it is not well to subject them to excessive handling.

Location and local conditions materially effect the ability of a set to receive distant stations. Antenna construction and ground conditions are important factors. If a loop is used the shielding of nearby metallic bodies will affect the results. In a case of loop sets it is advisable to install the set near a window. This is particularly true in the latest types of homes and apartment houses which employ in their construction metal lathing which acts as an electro-static shield to the incoming signals. In the case of sets employing antennas it will be necessary to experiment with antennas of different length and in different directions. However, before the service man blames the location as the cause of failure, he should take a set of similar make which he knows operates satisfactorily in another location, and check the results in the doubtful location comparing results received on the new set with those of the standard set. In a great many instances the service man is prone to use location as the cause of failure to receive distant signals whereas it may be due to a defective part in the radio set.

2. The signal comes in loudly and then dies out:  
This is generally due to the phenomenon of fading with which the customer has had no experience.

However, should this condition exist on the local stations, as well as the distant stations we would be inclined to suspect either a defective A battery connection or a defective A battery. A soldered connection in the filament circuit that has become corroded or broken for some unknown reason while not completely open so as to cause the tubes failure to light, but just making contact, will cause this condition. This defective connection at times will become highly resistant sufficiently so as to cause a decrease in the filament brilliancy. This condition is generally obvious as the brilliancy decreases at the time of the fading. This condition is rarely met but it is extremely difficult to locate. The defective connection requires careful inspection of every connection.

This condition may be brought about by a defective dry cell type A battery. In this case it is due to a local action within the dry cell. The internal resistance of the cell will vary due to this local action and cause effects similar to that caused by the defective connection just described. In the case of dry cells it is sometimes necessary to readjust the filament rheostats slightly in order to restore the sets to its normal operating condition and at times, the set will recover itself. In a storage type A battery this condition may be brought



about by a so-called treeing effect. This condition is generally only present in old storage batteries and is the result of a lead tree building up on the plates in such a way as to penetrate the separator. This lead tree builds up until it touches the opposite plate and causes a momentary short circuit of the plates involved. The short circuit burns off the lead tree and immediately the building up process is started again. When the short circuit occurs there will be a slight decrease in the total voltage of the battery which will cause a slight decrease in the filament brilliancy resulting in this fading effect. In cases of this type, the fading periods are only momentary and recur at fairly uniform time intervals and is present on all positions of the tuning scale.

A similar fading condition may be caused on sets employing an antenna or lead in. This condition should not be confused with the fading phenomenon and may be identified by the fact that the volume of the signal will not change gradually, but will swing in and out. The particular trouble to be encountered is when the antenna is close to a metallic or other conducting body and in swinging touches same, causing a momentary short circuit. This is recognized by a click in the loud speaker when the ground occurs.

### 3. Fading phenomenon.

To a person unfamiliar with the effect of fading, the tendency is to believe that it is set trouble; this, however, is not the case.

When receiving from a distant station the signal volume may suddenly begin to decrease, gradually fading until it nearly disappears. All the tuning or adjustments possible will not bring the signal back to the original volume until certain conditions change.

Again fading may occur with the signal entirely disappearing and, within the next moment or so, reappear and build up even louder than it was originally. All this may happen without so much as touching the controls of the set.

This action is called fading. There is no positively proven reason for this effect although there is an explanation which seems to account for it. This explanation is expressed by the Heaviside theory in the following.

The sun's rays in passing through the atmosphere of the earth produce an effect called ionization, and according to the Heaviside theory there is, at some distance above the surface of the earth, a layer of ionized air. This layer, it is thought, is not a smooth even surface but is believed to roll about similar to the waves of the sea.

Radio signals in leaving the transmitting antenna travel in all directions. Waves traveling downward penetrate the earth to a certain depth. Waves traveling in a horizontal direction over the surface of the earth, called ground waves, are gradually absorbed by various objects in their path and grow weaker as the distance from the trans-

mitter increases. Waves traveling upward are supposed to continue until they strike the Heaviside layer through which they will not pass but are reflected back toward the earth when coming in contact with this layer. Another peculiar phenomenon attributed to the Heaviside layer is that the radio wave is not always immediately reflected back but tends to glide along the underside of the layer in some cases for a considerable distance before finally being reflected back to earth.

The radio signal arriving at the receiver antenna is a combination of the ground wave and the wave traveling directly through the air upward to the Heaviside layer and which is reflected back to earth.

In daylight the waves traveling upward are for the most part absorbed and are therefore lost, the ground waves being the only waves received and which come directly to the receiver over the surface of the earth.

During darkness, however, this condition is changed. The ground wave and the reflected wave both reach the receiving antenna which, let us say, is within two or three hundred miles of the transmitting station.

The waves traveling upward to the Heaviside layer and reflected back, travel a greater distance than the ground waves in reaching the receiving antenna, therefore the reflected waves may strike the antenna a little later than the waves coming direct.

The combination of the two waves may be such that they completely balance out each other due to the positive alternation of one wave arriving at the same instance the negative alternation of the other wave arrives. When the Heaviside layer shifts, this changes the relation and the signals are again heard and in many cases become stronger than they were before.

The phenomenon of fading therefore cannot be attributed to the fault of the transmitter or receiver. At the present time it is beyond human control and nothing can be done with it until conditions responsible for the phenomenon change.

4. I don't get any volume, the signals are weak:  
If this condition is persistent and investigation shows that good results were never had on the receiver and found to be O.K., the difficulty would seem to be due to one of the following causes:

- Inferior type of set, or one not capable of producing expected good results.
- Defective tubes.
- Defective batteries.
- Reversed A battery connection.
- Poor antenna location or installation.
- Defective ground connection.
- Defective loud speaker.

These are listed in their order of importance and occurrence. If the receiver is of an inferior quality some advantage may be had by replacing the grid condensers and audio-frequency transformers with similar instruments of better quality. If it is due to lack of knowledge, it is the duty of the service man to instruct the customer more fully. Defective tubes should be replaced. This condition may be checked by replacing the entire set of tubes in the defective set with a set of tubes that are known to be O.K. A defective battery may be located by checking the voltage. It is generally conceded that a B battery whose voltage had dropped 25% from the normal rating of the battery should be discarded. If the A battery connections are reversed on receivers employing audio frequency amplification, little or no amplification will be had. This is easily checked by reversing the battery leads. Just when an antenna is defective is very difficult to say as there are so many local conditions which play important parts in the success or failure of an antenna installation. It should be removed as far as possible from all objects such as trees and buildings and metal objects in particular. In general the higher the antenna the better will be the results obtained. If the antenna is erected in the vicinity of a high tension transmission line, it should be erected so that the line of the antenna be at right angles to the transmission line. The antenna should be carefully insulated at all points throughout its length including the lead in. It will sometimes happen that a set employing an antenna operates quite satisfactorily during periods of dry weather, but during and after rain storms, the operation of the set becomes rather indifferent. This condition is generally due to a defective insulator which breaks down during periods of wet weather, causing high losses. An opposite condition may be had where the set operated more successfully during periods of wet weather than it did in dry weather. This would indicate that the moisture in the ground enhanced the value of the ground connection by reducing the ground resistance of the circuit. Some care should be exercised in the selection of a ground and the service man should not use the first ground tried. Several good ground connections should be tried and an effort made to determine the one giving maximum results, and this one used. In the present day equipment it seems to be customary to use an aperiodic circuit in the antenna, and for that reason defective grounds do not manifest themselves quickly. In antenna sets employing a series antenna condenser a defective ground will cause the antenna condenser to tune very broadly.

A loud speaker that has been connected into a receiver with the polarity reversed will after a time become demagnetized and result in very poor volume and quality. This condition, however, is rarely met.

5. The volume was great for a short time but suddenly started to weaken: This condition generally results from using an excess voltage on the tubes. It is particularly true in the case of sets employing dry cell tubes. The customer sometimes has a peculiar psychology and believes that by turning the rheostats of the tubes on full that he is getting better results. With the tubes used today employing thoriated Tungsten filaments this is a fallacy. Operating tubes using this type of fila-

ment at a greater than normal voltage deactivates the filament very rapidly and necessarily decreases its useful life. Under no consideration should a thoriated Tungsten tube be operated at a voltage higher than the rated voltage as indicated by the manufacturer.

A defective battery that has deteriorated abnormally will also cause this condition.

6. I can get WEAFF O.K. but WJZ is weak and they are both about the same distance away:

It is the general belief that this condition is caused by metallic obstructions such as steel buildings, high tension systems, railroads, and so on, or possibly mineral deposits near or on the earth's surface. It is believed that these obstructions cause either an absorption or a deflection of the radio waves which renders certain areas incapable of receiving signals from certain stations. Engineers recently carried out experiments in which they plotted the signal strength of WEAFF in different sections of New York City, and of the peculiar conditions that were noted. Certain areas in Central Park were practically dead to signals from this station. There is no remedy for this condition and it is not the fault of any particular set, as this condition would be true whether a crystal detector or a Super-Heterodyne be used in such a location. Of course the Super-Heterodyne circuit because of its sensitivity, would respond to an extremely weak signal that would be inaudible in a crystal detector set, but for practical considerations, reception in such an area would not be satisfactory, while at the same time give excellent results from other nearby stations.

7. It works O.K. for awhile but suddenly a howl starts which sounds like a siren or a fog horn which can only be stopped by shutting off the set or cutting down the volume.

This effect is due to a reverberatory air column which is set up between the loud speaker and generally the detector tube of the set. The action is similar to that which results when a receiver of a telephone instrument is placed in front of the mouthpiece of the transmitter. This condition is generally caused by a microphonic tube in the detector socket. It may also be due to a loose element in some part of the circuit. A loose transformer lamination or condenser plate might cause the same condition. The most popular theory of this condition is that the vibrating air column from the loud speaker causes a vibration of the tube characteristics which causes in turn a variation of the plate current, and an acoustic feed back results. This is a logical explanation of this phenomenon but is not universally accepted. In loud speakers of the adjustable type, adjustment of the air gap will sometimes eliminate this howl. In the case of non-adjustable loud speaker units it will be necessary to try interchanging the tubes in the sets in order to eliminate this condition. If interchanging the tubes does not correct it, place the loud speaker so that the bell points away from the set and place either the loud speaker or the set or both on pads of soft felt or sponge rubber. It is because of this effect that it is not advisable to place the loud speaker on top of the cabinet, unless the tube sockets are sufficiently cushioned.

This condition, however, usually occurs only when the set is operated at maximum output and the radio frequency amplifiers are set in an extremely sensitive condition. Reduction of the volume will invariably eliminate this howling effect.

8. The quality is terrible. We cannot understand a thing that is said: This condition is known as distortion and is due to many factors. As a general rule distortion occurs only in the audio frequency circuits. Distortion may be caused by a defective tube, a defective battery, a defective loud speaker, a broken down by-pass condenser across the output, or what is the most common cause of distortion, over-loading of the tubes. A soft or gassy tube will cause distortion, but this defect in a tube is rarely encountered in the standard make of tube. A weak or defective C battery is also a very common cause of distortion and will be evidenced by a tendency of the amplifiers to squeal. When the B battery voltage has dropped 25% distortion will often result and may be accompanied by a continuous high pitched squeal. Audio frequency transformers of poor quality and design will cause distortion. This is generally indicated by the inability of the amplifiers to reproduce the extremely high and low musical tones. A transformer in which the leads have been soldered with a corrosive flux will cause distortion a short time prior to the time when the corrosive action of the flux will cause the winding to open. Both these conditions call for the replacement of the defective transformer. Over-loading of the amplifier tubes is evidenced by a blasting of the loud tones of the program. This is particularly true on local reception. The customer should be instructed to watch the overloading of the tubes and if the blasting does occur, he should de-tune his set slightly so as to reduce the volume to the point where the tubes will function properly. It is quite possible with the multi-tube sets used today when installed in the vicinity of a powerful broadcasting station, to impress on the grid of the last tube in a series, sufficient voltage so as to swing the grid voltage beyond the limits of the straight line position of the characteristic curve. Increasing the C battery potential or voltage on the amplifier tubes will tend to reduce this blasting. But this is not recommended as general practice because of the possibility of increasing the negative potential to such a point as to cause distortion when the tube is operating with normal volume. A great many amplifiers in receiving sets use a fixed condenser ranging in value from .002 to .006 connected across the loud speaker terminals. This condenser is known as a bi-pass condenser and is subjected in this part of the circuit to considerable peak voltages. Should this condenser fail, a distorted signal will result. If on servicing this condition is met and all the foregoing items have been checked with no results, replace this bi-pass condenser, as a potential breakdown in this condenser is rather difficult to test for unless laboratory equipment is available.

9. It is loud enough but very noisy, there is a continuous cackling rasping or scratching sound in the loud speaker: This may be the result of a great many causes. Interference from either atmospheric or local sources is the most common cause of this defect.

By local sources we refer to such apparatus as X-ray machines, violet ray machines, electric railway systems, elevated controls, leaky power lines or transformers, automatic telephone switching lines, telegraph lines, and local telegraph stations in the vicinity of the receiver.

In checking noises in a radio receiver the first problem should be to determine whether it is being picked upon the antenna or the loop, or whether it is originating in the set itself. In order to check this on a set employing an antenna, adjust the receiver to a point where the interference or noise is present. Then remove the antenna and ground connections from the receiver and note whether or not the noise ceases. If there is a great decrease in the volume of the noise when the leads are disconnected, it is safe to assume that the noise is emanating from an outside source.

If a loop set is employed, disconnect the loop and place a short length of wire not over four inches in length in place of the loop. If the noise ceases when the loop is removed it may be safely assumed that the noise originates at some outside source. However, if the noise persists after the pick-up circuit, either loop or antenna, is removed, it is safe to assume that the noise is originating in the set itself. The noises referred to in the foregoing are those which are present at all times, particularly when none of the controls are being moved. Noises within the set itself may be caused by one of the following items:

- A defective tube.
- Dirty tube contact.
- Defective battery.
- Defective loud speaker.
- Dirt on loud speaker diaphragm.
- Defective battery contact or loose connection.
- Defects in battery eliminating devices.

The defective tube should be replaced by a tested one. The tube contacts should be cleaned with a piece of emery cloth or fine sand paper. Make sure to remove all traces of grit before replacing the tube. Make sure the contact springs of the sockets are clean and are making good contact to the contact pins of the tube. A defective battery will also cause all kinds of noises in a receiving set. The batteries should be checked in the following manner: Connect a pair of headphones across the outside terminals of each individual battery, and note the sound in the headphones. If there is a boiling or frying sound in the headphones when they are connected in this manner, it is an indication of a defective battery, and batteries showing such defects should not be used in a radio set. A loose or defective battery connection will also cause a set to be noisy. A loud speaker with a defective winding will also cause disagreeable noises. Dust and dirt on the loud speaker diaphragm will cause the set to appear noisy. A condition might arise, where the diaphragm of the loud speaker would become loosened and cause it to rattle when actuated by the incoming signal. Loud speaker defects generally necessitate a factory repair. A transformer winding which is deteriorating will also cause a hissing or frying sound in the amplifier.

A loose connection in any part of the receiver and loud speaker, which is subject to vibration when the loud speaker is operating will also cause the set to be noisy. In order to definitely locate the origin of noises in the receiver, use a pair of headphones and plug them in place of the loud speaker. This will immediately determine whether the noise is originating in the loud speaker. If the noise persists with the phones plugged in the last stage of amplification, plug into the first stage, if a jack is provided, and repeat the process plugging into the detector circuit. If but a single jack is provided, and this jack is connected in the output of the audio frequency amplifiers in order to determine whether or not the noise is originating in the audio frequency amplifiers, connect the telephones in series with the detector B battery lead. In that way, you may determine whether or not the noise is originating ahead of the detector or in the audio frequency amplifiers. Once the source of the noise is determined it requires very careful checking of the various parts and connections in the circuits responsible.

10. Set operates satisfactorily except when any of the controls are moved it is very noisy:

This condition indicates directly a defective connection caused by a mechanical failure. A defective tube will sometimes cause this condition, and is apparent when a rheostat is moved or the set is subject to mechanical vibration. If the noise persists when any of the controls are moved such as condensers and coils, it is an indication that there is a mechanical failure which is causing a defective electrical connection. Dust and dirt accumulations on the condenser plates will also cause noises to be heard when the condensers are rotated. The plates should be cleaned with an ordinary pipe cleaner. A bent condenser plate touching the opposite assembly will also cause this condition. Some variable condensers are constructed so that the electrical contact is made through a friction washer or through the friction of the rotor shaft to the bushing. This type of contact is quite satisfactory when the condenser is new but after a long period of operation the parts wear, decreasing the friction resulting in an indifferent contact which will at times cause the set to appear noisy, particularly so when the circuits of the receiver are tuned to resonance. Vernier drive shafts that have become worn through use will cause the sets to be noisy when the circuits are in resonance. Weak contacts in telephone jacks will also cause this condition.

11. When I take my hand away from the set I lose the signal:

This effect is known as the "body capacity effect" and is primarily due to a poor design or a poor ground connection. Grounding of the A battery will sometimes be helpful in eliminating this body capacity effect, but it should be first determined whether or not there is a connection between the ground terminal of the set and the filament circuit. For example, if the positive filament circuit is connected to the ground terminal, the A battery should be grounded at the positive terminal. If the ground terminal of the receiver is connected to the negative side of the filament circuit within the set, the negative terminal of the battery should be grounded. In sets of proper design in which shields have been incorporated and this body capacity is present we would suspect that the

shield has become disconnected from the ground or battery circuit within the set.

12. There is a frying sound in the set:

This condition may be brought about by a defective battery, defective tube, a ground in the loud speaker, a defective battery connection, a transformer that is burning out, or in the case of a set employing a gas type 200 detector tube an excessive B voltage on this tube. The defective tube may be located by replacing the tubes with tested ones. The defective battery should be checked with headphones as described previously. A defective loud speaker may be determined by replacing same by headphones. All battery connections should be tightened. The defective transformer may be determined by a similar test that is used to locate a defective battery, except that a battery that is O.K. is used and connected in series with the telephones and the winding of the transformer under suspicion.

13. When I touch the panel there is a ringing sound:

This is invariably due to a microphonic tube and may be eliminated to a certain extent by interchanging the tubes until the best combination is had. The detector and audio frequency amplifier tubes are the principal offenders in this connection. In sets employing dry cell operated tubes such as the WD (or WX) 11, or the UV (or UX) 199 this condition is greatly exaggerated unless the tube sockets are properly cushioned. There is always a certain amount of this condition present in all receivers, even under normal conditions, and it is another reason why the cushion type socket suspension is used.

14. There is a squealing sound in the set all the time:

This condition may be caused by a defective tube, one that has become soft or gassy. This may also be due to a defective B or C battery that has dropped in voltage. A burned out primary winding of a transformer or an open telephone jack in the audio frequency circuit will cause this squealing. Another cause may be the result of the heterodyning of two transmitting stations, or it may be the effect of a nearby receiver interfering with the one in use, however, under the last conditions the squeal will be present at certain definite places on the dial whereas in the case of a defective battery, tube, transformer or jack, it is continuous throughout the entire scale reading.

15. There is a clucking sound in it:

This is a general indication of an open grid circuit. The frequency may vary from one click a minute to a very high pitched note. If the grid leak should become loosened from its clips this sound will generally result. If a C battery is used, a poor connection or broken connection to this battery will give the same result. If none of these conditions appear to be the difficulty, it will be necessary to make a continuity test from the grid contact spring of each socket to the filament circuit.

16. When I touch anything on the set a rattling sound sets up or the set will sometimes go dead and a jar will restore it:



This is caused primarily by a loose connection either in one of the tubes or in any connection of the circuit. Investigation of every connection and friction contact in the set should be made. It is well to replace the tubes with tested ones in order to eliminate the tube as a factor. A loose shield will sometimes cause this.

17. It works in the detector jack but does not operate in the first or second stages:

If the A battery connections to the amplifier are properly made this condition is probably due to a defective telephone jack in the detector circuit or a burned out primary winding of the audio frequency transformer connected in the detector circuit.

18. It works O.K. in the first stage Audio Frequency Amplifier but does not operate in the second stage:

This is due to a similar reason as just previously given. It is caused by a defective telephone jack or transformer in the first audio frequency circuit.

19. The tubes fail to light:

This condition may be brought about by a defective A battery or a defective A battery connection. It may also be due to a faulty battery switch, that fails to make proper contact. In the same way, a rheostat that does not make proper contact, will cause the same effect. Any loose connection in the A battery circuit of the set may cause the failure of the tubes to light. If this condition exists only on one or two tubes, it is in all probability due to a burned out filament. A dirty contact on the tube will sometimes cause the failure of a tube to light. If the contact springs of the socket do not make a firm contact to the tube pins this condition might also occur. If dry cells are used, check to see that the individual cells are connected in the circuit with the proper polarity. If one or more of the cells are connected in with reversed polarity, full voltage will not be had at the tube terminals.

In general, the service man should follow a procedure somewhat along these lines. Light the tubes and tune the receiver to the point where the best local station generally is received. He should note the volume on the loud speaker, if one is used. If the volume is weak, tap the tubes with the fingernail to determine whether or not the audio frequency amplifiers are operating satisfactorily. If the amplifier is working satisfactorily, a ringing sound will be heard in the loud speaker. If this ringing does not result, check the polarity and voltage of the various batteries, and replace all the defective ones. Inspect the connections of the batteries. If this does not result in satisfactory reception, try replacing the tubes. If no sound at all results immediately replace the loud speaker with the headphones to determine whether or not the loud speaker is defective. If no results are obtained, turn off the A battery switch and remove the tubes, and by means of a voltmeter, check the voltage between the filament and plate contact springs of each socket. If satisfactory indications are had and no signal is heard, repeat with a similar operation between the grid and filament contacts, using a pair of headphones in series with a

22½ volt battery in place of the voltmeter. Rather decided clicks should be heard, when contact is made in each instance with the exception of the detector grid. Because of the fact, that in the detector circuit, a high resistance grid leak is used, the click will be rather weak. One of the foregoing tests will most probably check up the difficulty and the obvious repair should be made.

The foregoing is a general review of some of the principle troubles that may occur in the radio receiver. There may be a few troubles that apply to a single type of receiver which have been omitted, but they will be characteristic of that particular type. In conclusion, we would repeat to the dealer which we believe to be helpful suggestions in reducing service to a minimum: Test all sets before sale and be truthful in the matter of results that may be expected. Do not lead the customer to believe that he will be able to receive California any time he desires. Advise him also of the probable length of life of his batteries. To a service man, ask questions and analyze the defects before you commence operations. A few judicious questions will oftentimes save considerable work and create a more favorable impression with the customer.

#### EXAMINATION - LESSON 35

1. What is usually the trouble when a ringing noise is emitted by the loud speaker?
2. If a "frying" noise is heard what is likely to be the trouble?
3. Do atmospheric conditions have any effect upon reception? If so, in what way?
4. What should a service man do before taking a set apart for repairs?
5. What are some of the conditions that may cause fading?
6. What is usually the cause of weak signals?
7. Has the location of a set anything to do with the quality of reception?
8. What are some of the reasons why the tubes may fail to light?
9. Why is it that a set may operate satisfactorily for a long period of time and then, for no apparent reason at all, begin to "howl"?
10. Name several of the general causes why a receiver may fail to operate?